Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE
AMERICAN NATURALIST.

Vol. I.—DECEMBER, 1867.—No. 10.

DESMIDS AND DIATOMS.

BY PROF. L. W. BAILEY.

It is the purpose of the present article to present in a familiar way the more important features in the structure and history of some organisms in general but little known, the Desmidiaceæ and Diatomaceæ, and to suggest a few reflections upon their habits and economical value, but more especially their importance, both in past ages and at the present time, in modifying the physical features of the globe.

Without entering into the facts of the discovery and history of these microscopic Algæ, it may be sufficient to say that they were originally included, together with two other very interesting groups, the Polygastrica or Many-stomached animals, and the Rotatoria or Wheel-animalcules, by the Prussian naturalist, Ehrenberg, under the common name of Infusoria. It is much to be regretted that a systematic classification, embracing numerous sub-families, genera and species, should thus have been introduced into scientific nomenclature, at a period when so little was really known of the true position of these organ-

---

Entered according to Act of Congress, in the year 1867, by the Essex Institute, in the Clerk's Office of the District Court of the District of Massachusetts.

isms, and that names devised to represent their supposed characters, but calculated to lead into constant error, should thus have been perpetuated. The name of Infusoria, applied to the whole assemblage of animated forms first revealed by the microscope, was derived from the invariable presence of these bodies in all infusions of decaying animal and vegetable matters. It is to their rapid appearance and development under circumstances calculated to remove or destroy all germs of organic life, that the doctrine of *spontaneous generation*, still maintained by many able observers, owes its origin. Into the character and habits of the Infusoria proper, or Protozoa, as they are now called, as well as those of the Rotatoria or Wheel-animalcules, I do not now propose to enter. Suffice it to say, that the two remaining families, the Diatoms and Desmids, after repeated tossing from the one kingdom to the other, are now universally admitted into the department of the botanist, and can really have nothing in common with that of the zoölogist.

The Desmids and Diatoms were grouped together by Ehrenberg, under the single name of the Bacillariæ, from *bacillum*, a rod or wand, a name singularly inappropriate as applied to the whole family, including as it does a large proportion of forms having no such resemblance. By naturalists of later years the two are included as coördinate suborders of the minuter Cryptogamia, termed Algæ by botanists.

The Desmids, or Desmidiaceæ, so called from the partial division of the single cell of which they consist into two by a deep constriction in the middle, which is highly characteristic of the whole family, are pseudo-unicellular algæ of a beautiful green color and great variety in size and outline. Unlike the Diatomaceæ, they are confined solely to fresh water, where their delicate green cells, forming mucous tufts or films on the surface of boggy pools, or coating the stems or fronds of aquatic plants, often multiply in sufficient numbers to impart a pale green tint to the water. Only the most quiet and the purest water seem favorable to their growth. Running streams, brackish inlets, the turbid waters so productive of the minuter forms of animal life, seem wholly unfitted for these delicate organisms. As a general rule they are much less numerous than the Diatoms, the latter far exceeding them in families, genera, and species, as well as in the number of individuals. Their outline is very varied, but generally characterized by a great number of incisions of greater or less depth, which seem constantly tending to divide the original cell into a number of smaller ones. Many of them have in general a circular outline, but still marked with deep constrictions (as *Micrasterias*, Pl. 13, fig. 4), others are lengthened and sigmoid (*Closterium*, fig. 5), recalling some genera among the Diatomaceæ; others, again, are compound or concatenate; and yet others, like the Diatoms, form long and waving graceful filaments. A tendency also towards outward development, as shown in the numerous projecting arms which are so prominent on many species (figs. 1, 2, 6), is also a noticeable feature in their structure, and aids greatly in the determination of their specific characters and their relations to other families.

The Desmids consist, as I have said, essentially of a single cell. This cell has the usual number of external coatings, a membrane of firm though flexible consistency, often containing particles of silica, and showing the affinities between this family and the Diatomaceæ; a second coating or "primordial membrane" included within the former, and containing within its cavity the "endochrome," or green coloring matter, which seems to be analogous to the chlorophyl or leaf-green of the higher plants; and, lastly, a thin hyaline membrane enclosing the two former, and analogous to a similar membrane among the Diatomaceæ. The surface of the cell thus enclosed is often ornamented by the existence of numerous markings, striæ, lines or dots, but still oftener by the presence of projecting points or spines, which give to many of the genera a singularly beautiful appearance. In the interior of this cell may sometimes be seen a curious movement of the cell contents, which has given rise to much discussion among the students of these forms. Some assign the circulation thus witnessed to ciliary action, others to the spontaneous movement of enclosed zoöspores; but as this is still a debated point, I shall not at present dwell upon it. The same is true of the motion quite commonly observed of the whole Desmid through the medium in which it lives, with a slow majestic movement, very suggestive of animality, and which caused these organisms to be assigned by the earlier writers to that kingdom. The existence of external "cilia," either in these or in the Diatomaceæ is exceedingly improbable. Like other plants, they have a marked tendency to travel towards the light, and have sufficient power of locomotion to penetrate to the surface of mud in which they have been imbedded during the drying up of pools.

The multiplication of the Desmids is accomplished by two methods: by self-fission, or the dividing of the cell-contents into two portions, as is commonly the case with all Algæ; or, secondly, by a true generative process, and the formation of "Sporangia." As, however, these processes are very similar to those which characterize the reproduction of the Diatomaceæ, and as it is chiefly of the latter that this article is designed to treat, it is unnecessary to enter into a more minute description.

Before dismissing the subject of the Desmidiaceæ, I may say that they are exceedingly common, especially in open tracts, abounding in exposed localities. They are exceedingly beautiful, and, with the Diatoms, which are always associated with them, form objects well worthy of search on the part of those provided with the proper instruments to discern their beauties. They are very tenacious of life, I having frequently found them still green and healthy in bottles of water from which all other varieties of vegetable life had long since disappeared. As agents in the mechanism of Nature, the Desmids play an important part, not only by directly serving as the food of many aquatic animals, but also by their furnishing, in company with other plants, the oxygen which is so necessary for the purity of the water in which these animals are to dwell.

Lastly, the Desmids have a peculiar interest from the fact, that, notwithstanding their being destitute of the hard parts which constitute the fossil remains of other plants and animals, they are yet found in considerable numbers in the fresh-water marls of North America, and bodies bearing a striking resemblance to their Sporangia occur abundantly in the silicious nodules of the chalk, and even in the flinty hornstone of the Silurian and Devonian eras.* To this fact allusion will again be made in the discussion of the geological relations of the Diatomaceæ.

---

*It is generally stated that these organisms, termed Xanthidia, are the sporangia of Desmids; but if so, how is it that they occur in marine deposits, such as the chalk and hornstone, while the recent Desmids are exclusively fresh-water forms? In allusions to these fossils this fact seems to have been generally overlooked.

The close analogy existing between the structure and mode of growth of the Desmidiaceæ and that of other undoubted unicellular Algæ became evident with the rapid improvements in the instruments of observation. Not so, however, with the Diatomaceæ, for although the opinion is now almost universal among those most competent to decide the question, that they are truly vegetables, this conclusion was long opposed by able writers, and even now is by some authorities strenuously disputed. With the majority of observers I will assume their vegetable nature, and endeavor to describe the most important features in their structure and mode of growth.

The Diatoms (from *dia* and *temno*, to cut in two) are, like the Desmids, unicellular Algæ, consisting essentially of two plates, concavo-convex, bacillar, hemispherical or depressed, connected together by a band or hoop called the "connecting membrane," applied to and coinciding with the circumference of the valves, and enclosing within a coloring matter, which, unlike that of the Desmids and most true plants, is of a yellowish or orange-brown color. The form, structure, and marking of these valves are often very complex as well as beautiful, and are of vast importance in the classification of these organisms. As to *form*, the Diatoms present an infinite variety of size and outline. Mathematical curves of the most exquisite perfection, combinations which the designer would grasp with eagerness in the planning of his models, surfaces adorned with the most unlimited profusion of style and ornamentation, are everywhere presented. They may conveniently be arranged under two great heads; first, of the forms more or less linear or bacillar in outline, including most fresh-water species; and, secondly, those which are discoid, almost solely marine. This division is not an accurate one, many linear forms being marine, and a few discoids fresh water, but the distinction is a convenient one, and sufficiently characteristic to apply to the majority of cases.

Among the forms whose general outline is linear, we have those which are straight and free (such as *Nitschia*, Pl. 13, fig. 8), those whose "frustules," as the separate individuals are termed, are adherent by the base, and which produce fan-like clusters, or even star-shaped aggregations (as in *Synedra*, fig. 33; *Asterionella*, fig. 17; and *Licmophora*, fig. 20) ; those with the individuals adherent by the sides, and producing lengthened filaments (fig. 18), which if one end of the cell be smaller than the other, will give rise to spirals (as in *Meridion*, fig. 12), or again lying free with others of its kind in a sort of gelatinous envelope or cushion (as in *Mastogloia*, fig. 19, *Encyonema*, etc.), or adhering by alternate corners and producing zigzag chains (as in *Diatoma*, fig. 16; *Grammatophora*, fig. 30; *Tabellaria*, fig. 13) ; or, lastly, not included in either of the above divisions, but still having a certain general resemblance to the typical straight line (as *Cocconema*, *Gomphonema*, etc.). These are by no means natural or scientific divisions, but aid in fixing in the memory their characteristic shapes. Between each other and the second great class of circular or discoid forms, there is every variety of gradation, the one insensibly passing into the other. The latter, or discoid forms, which, as I have said, are mostly but not exclusively marine, are also characterized by even greater variety of form and outline, often exceeding in beauty of conception and in delicacy of execution the most elaborate works of human ingenuity. As a general rule the surface of their valves is more or less broken into numerous dots, depressions, or elevations, and frequent areolations, circular or hexagonal. This is a very general character of all the Diatomaceæ, and is due to the deposition of layers of silex variously disposed within or between the different membranes which enclose the cell, and which, remaining persistent and retaining all their delicate sculpturing after the removal of the organic contents, are the portions which become fossil and which, even in recent gatherings, are the chief features used for the discrimination of the species. Frequently several different modes of ornamentation are visible upon the same shell, and are possibly situated in its different layers. The exact position, and the number of such membranes, and the nature of the markings, are still subjects of discussion among the students of these forms. The presence of this silex, however, is the fact of most interest in their structure, whether they be regarded in a strictly scientific, or in an economical point of view.

Among the discoid forms may be enumerated those with a circular outline, and circular or hexagonal areolations (such as *Coscinodiscus*, Pl. 13, fig. 34; *Craspedodiscus*, etc.), those with a circular valve divided into partitions by radiating lines (as *Arachnodiscus*, fig. 29), those with a simple disk, but united into continuous filaments (as *Podosira*, fig. 25; *Melosira*, etc.), those with a more or less circular outline, but with the surface projecting into spines or processes which seem to connect adherent frustules (as in *Biddulphia*, fig. 31; *Eupodiscus*, etc.); or, lastly, of forms not truly circular in outline, but really modifications of the circle, and approaching that shape by insensible gradations (as *Triceratium*, fig. 27; *Amphitetras*, fig. 36; *Campylodiscus*, *Surirella*, etc.). As a rule, the circular forms may be compared to tolerably flat thin pill boxes, or, still better, to a common watch. One genus, indeed, the *Hyalodiscus*, when magnified over 2,500 diameters, bears a striking resemblance to the covers of an engine-turned watch, two sets of delicate dots radiating in eccentric curved lines from the centre towards the periphery, and giving to the shell, under bright illumination, a truly exquisite appearance. Some have the disks so convex as to make a nearly spherical figure, others have the surface depressed at the centre, while others again are beset around the margin with a glittering row of spear-like points. The imagination can scarcely picture a form of beauty which does not find a counterpart among these most wonderful of Nature's medallions.

The multiplication of the Diatoms, like that of the Desmids and other unicellular Algæ, takes place according to one or the other of two modes, either by simple cell-multiplication, the original frustule dividing into two which again subdivide, or else by a true generative process, and the formation of Sporangia. The first method is exceedingly common, so much so, indeed, that we can scarcely find a specimen in which the process is not just ended, or in some stage of advancement. This multiplication takes place by the gradual enlargement or widening of the "connecting membrane" before alluded to. (See Pl. 13, figs. 31 *a*, and 23 *a*.) Nearly at the beginning of this process the contents of the cell are divided into two portions, while the lining or inner membrane of the parent cell becomes doubled inwards in an annular ring about the whole circumference along the line of division. This infolding membrane continues to advance, until a nearly complete division has taken place of the old cell into two new ones, the two new contiguous valves becoming impregnated with silex before they have become free of the connecting membrane. (Pl. 13, fig. 31 *a.*) In this way a complete septum is formed, the two new frustules often remaining enclosed within the connecting membrane, like the inner tubes in a telescope. These new cells, which in every way are the exact counterpart in size and structure of their parents, may remain thus enclosed, but more frequently are left free by the falling off of the connecting membrane. The new frustules thus formed, by the greater or less adhesion among themselves, which differs in different species, give rise to all the different forms of aggregation already alluded to. If adherent side by side, the effect is to produce a lengthened filament, either straight (Pl. 13, fig. 18), or spiral (fig. 12) ; if adherent only at corresponding corners, a star-shaped figure is produced (fig. 17) ; if at alternate corners, a zigzag chain (fig. 16). Frequently processes of greater or less size are developed at the corners, which serve as means of adhesion between the two (fig. 23). Lastly, the division may be complete, and the resulting cells remain aggregated in a spongy mass (fig. 19) ; or else, entirely free, swim slowly through the medium in which they live (figs. 9, 10, 28, 32, etc.).

Of the contents of the cells or "frustules," their chemical composition, changes, and internal movements, it is unnecessary now to speak. Suffice it to say, that the existence of the so-called *stomachs*, organs of locomotion, etc., which Ehrenberg asserted that he had detected in their interior, have been entirely disproved by the researches of later authors. The "endochrome," as I have already said, is of a different color from that of most plants, and is even supposed by many to be of a different chemical composition; but in most other respects their resemblance to true plants is very marked, and as they bear the closest analogy to the Desmids, which all observers now admit to be vegetables, it can scarcely be doubted that they, too, are of the same nature.

One of the greatest obstacles to a belief in the vegetable nature of the Diatoms has always been the wonderfully curious motions which nearly all of them exhibit in their living state. This is not a merely mechanical motion, due to light or other external agents, although they share this property with other known plants, but they seem to have a certain internal principle of locomotion peculiar to themselves. They may constantly be seen swimming through the water, with a motion slow, to be sure, when we consider how much that motion is magnified, yet certainly as rapid as that of many undoubted animals among which they dwell. As a general rule these motions are simply backwards and forwards, any interposing obstacle being pushed aside, but not avoided; at other times, the motion is a slow rolling from side to side. In one species, however (the *Bacillaria paradoxa*, (Pl. 13, fig. 18), so singular are the movements exhibited, and so unlike anything that occurs either in the animal or vegetable kingdom, that they never fail to excite astonishment in those who, for the first time, behold the curious phenomenon.

Like a lengthened ribbon, crossed by numerous close and parallel bands or bars, the Bacillaria frequently attains a length of an inch or more. Hanging from some green confervoid plant, or floating freely in the water, this fragile form, transparent and lustrous as the finest spun glass, is at first quite motionless. Slowly detaching itself, however, at one end, a strange activity will soon become apparent throughout its entire length. Each glassy bar takes upon itself an individuality, and though still connected with the rest, moves as with an impulse of its own. The middle bar alone is motionless. Those on either side slide gently on the last, the one to the right, the other to the left, with clock-like regularity. The movement of the first is the signal for all the rest. Each in turn slips quickly along his neighbor's side, until from a long and ribbon-like band, we now have a series of glassy steps, each crystal bar resting slightly upon that below it. But the change is transient. When the whole series has thus unfolded, as it were, it begins to slowly recoil again. Each plant or bar resumes its former place, and the ribbon-like band again hangs motionless from leaf to leaf.

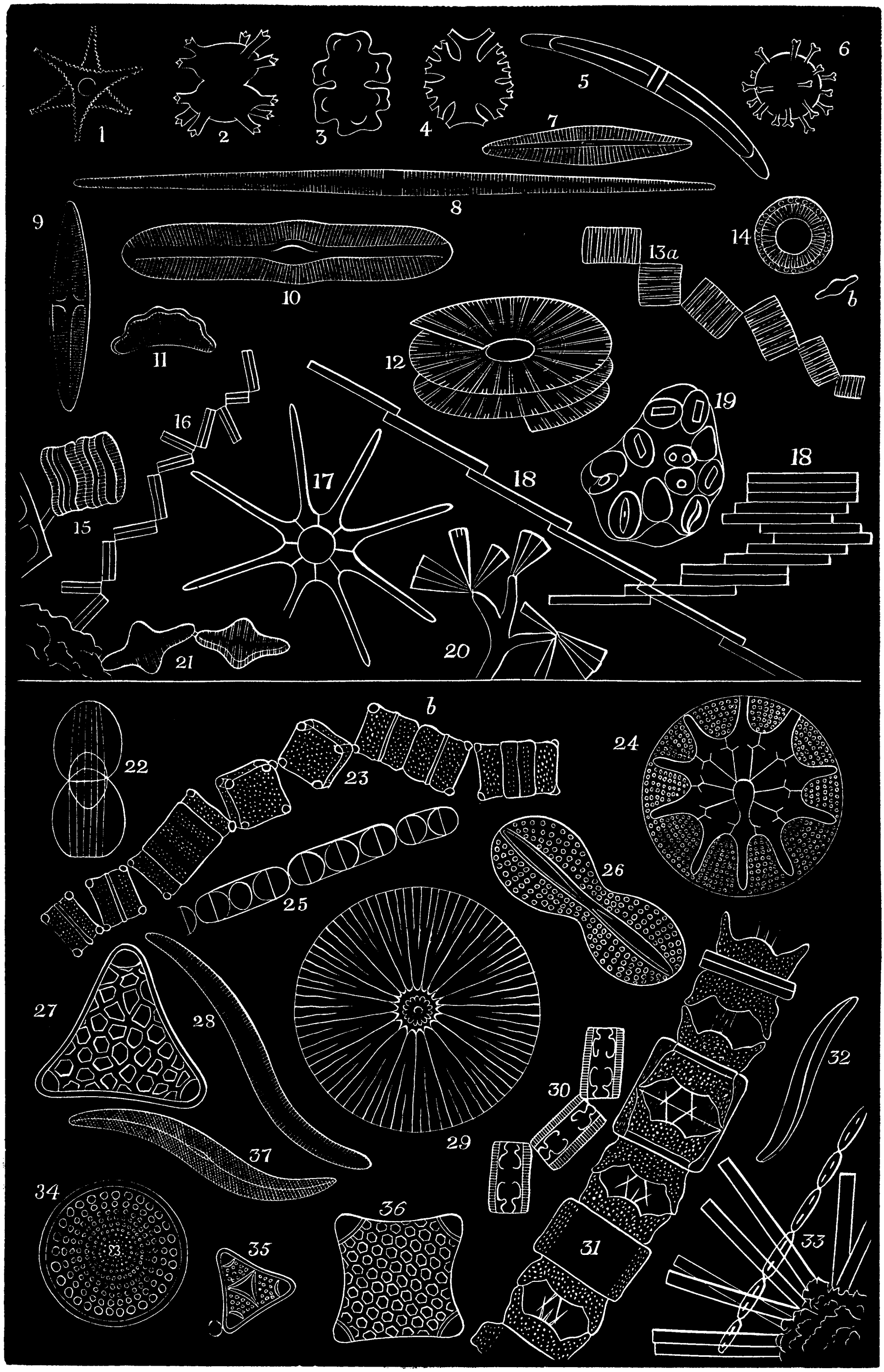
The cause of these motions has been severally assigned to the action of minute vibratory cilia, to an undulatory motion of the outer membrane, and to the mechanical effects resulting from the absorption or discharge of water. The subject, however, is one which yet remains in great obscurity.—*To be concluded.*

EXPLANATION OF PLATE 13.

Figs. 1-5. Desmids,—1 and 3, Euastrum; 2 and 6, Xanthidium, resembling fossils found in flint; 4, Micrasterias; 5, Closterium.

Figs. 7-21. Diatoms,—*Fresh-water.* 7, Navicula; 8, Nitschia; 9, Stauroneis; 10, Pinnularia; 11, Eunotia triodon; 12, Meridion vernale; 13, Tabellaria flocculosa,—*a*, front view, *b*, side view; 14, Cyclotella Kützingiana,—*b*, side view; 15, Acnanthes; 16, Diatoma flocculosum; 17, Asterionella; 18, Bacillaria paradoxa; 19, Mastogloia; 20, Licmophora; 21, Odontidium.

Figs. 22-36. Diatoms,—*Marine Forms.* 22, Amphiprora; 23, Amphitetras, forming a zigzag chain,—*a*, a frustule about to divide into two, *b*, two frustules newly formed but not yet separated, the "connecting membrane" having fallen off; 24, Asteromphalus, a beautiful deep-sea form, taken from below 2,000 fathoms in the sea of Kamschatka; 25, Podosira; 26, Navicula didyma; 27, Triceratium; 28, Nits-



BAILEY ON DESMIDS AND DIATOMS.

chia; 29, Arachnoidiscus; 30, Grammatophora; 31, Biddulphia, — *a*, two frustules, still enclosed by the "connecting membranes," *b*, "connecting membrane," widening previous to self-division; 32, Pleurosigma; 33, Synedra; 34, Coscinodiscus; 35, Triceratium; 36, Amphitetras.

The forms are not accurately drawn to scale, but are for the most part magnified about four hundred diameters.

A BOTANICAL EXCURSION IN MY OFFICE.

BY PROF. HORATIO C. WOOD, JR., M. D.

PROBABLY most of the readers of the NATURALIST have, at some time or other in the last five years, owned, or at least been interested in aquaria. If what happens in Philadelphia may be taken as an index, many such observers of water-life have been pestered by a minute growth, which seems to flourish alike on plant or stick, on the living and dead. Last winter and spring the writer of this article had a small aquarium, which, as far as plants were concerned, was stocked chiefly with the *Ceratophyllum*, or hornwort, which, as is well known, possesses a vast abundance of finely dissected, twig-like leaves. Glancing one day at his water-garden, he noticed on these little cylindrical divisions a fine hazy fringe, scarcely to be perceived except by allowing the light to shine through the vessel containing the plant. Now this fringe, this nebulous garment clothing the hornwort, was the minute growth alluded to, which, though not strictly parasitic, not feeding on the plant to which it is attached, is, in most cases at least, associated with a sickly state of the larger plants, and certainly detracts from their beauty when viewed with the unaided eye, as in aquaria. But let us take our forceps, break off one